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LISTS OF SPECIES

Vascular flora of semi-arid region, São José do Piauí, state of Piauí, Brazil

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ABSTRACT: The Caatinga biome is located in the semi-arid region of northeastern Brazil and covers about 37 % of Piauí state. The main objective of the present study was a characterization of the Caatinga flora of the farm of Morro do Baixio, in state of Piauí, Brazil (06°51'13" S; 41°28'15" W, at 400 to 540 m above sea level) in view of the fact that very few such surveys were conducted in the state. The flora of the farm was surveyed monthly, during a year, to gather herbs, epiphytes, parasites, sub shrubs, shrubs and trees. We encountered 136 species belonging to 46 families, including a new species of *Bauhinia*. The richest families were Caesalpiniaceae (15 spp.), Fabaceae (11 spp.), Bignoniaceae and Mimosaceae (both with nine spp.). We observed a higher frequency of typical species from sedimentary Caatinga. However, local conditions favor the appearance of species that occur in Carrasco and Cerrado.

INTRODUCTION

The semi-arid of Brazil extends over 800,000 km^2, approximately 10 % of the national territory within the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Northern Minas Gerais, delimited by the medium isoieta of 800 mm (Ab'Sáber 1974; Hueck 1972). This region presents heavy rains in some years, prolonged drought periods in others, with irregular and concentrated in a few months, higher evapotranspiration rates and low infiltration capacity of soils (Ab'Sáber 1974; Reis 1976; Kampen 1979).

The Caatinga is the dominant vegetation of the semi-arid region (Luetzelburg 1923; Engler 1951) which has been suffering severe environmental degradation in recent decades, mainly as a consequence of rural growth and expansion of agriculture and cattle grazing. Among different types of Caatingas, those located in sedimentary areas have been the focus of very few studies until recently.

The state of Piauí accounts for 37 % of the area of Caatinga biome and according to Sampaio (2002) 118 municipalities within the state are included in the semi-arid domain. The lack of such information has motivated the inclusion of sites such as the microrregion of Picos in Piauí as priority area for the conservation of the Caatinga biome (Silva *et al.* 2004).

In the present study, we aimed provide a check list the vascular flora of the municipality of São José do Piauí, a priority area for conservation, identifying the species which occur in the region in crystalline and sedimentary formations and determining whether the life-forms differ from the normal spectrum of Raunkiaer's system.

MATERIALS AND METHODS

The present study was carried out in the municipality of São José do Piauí, within the Picos microrregion in Piauí state, in a privately owned property called Morro do Baixio (06°51'13" S; 41°28'15" W, at 400 to 540 m above sea level) (Figure 1). According IBGE classification (Veloso *et al.* 1991), the vegetation is characterized by steppe-savana. Based on temperature data, estimated through linear regression equations, and precipitation of 14 years (1984-1998) obtained from the São José Meteorology Station (Secretaria de Agricultura, Abastecimento e Recursos Hídricos – Departamento de Hidrometereologia), the mean annual rainfall was 816.~~4~~ mm, with nine months of water deficit. The climate is Dd2A'3a' (Thornthwaite and Mather 1955), characterized as semi-arid with little hydric excess and small thermal annual amplitude. This area is dated to Paleozoic and belongs to the sedimentary firth of Piauí-Maranhão. The lithology is characterized predominantly by sandstones, shales and silts of the Serra Grande, Pimenteira and Cabeça formations. Geomorphologically, it is located in the Eastern Plateau of Piauí, with the surface exhibiting varied dissection features (Jacomine *et al.* 1986; Ramos and Sales 2001).

The vascular flora was surveyed monthly, during a year in a 2 ha area, to collect herbs, epiphytes, parasites, lianas, sub shrubs, shrubs and trees, throughout the study area. All specimens collected were identified and

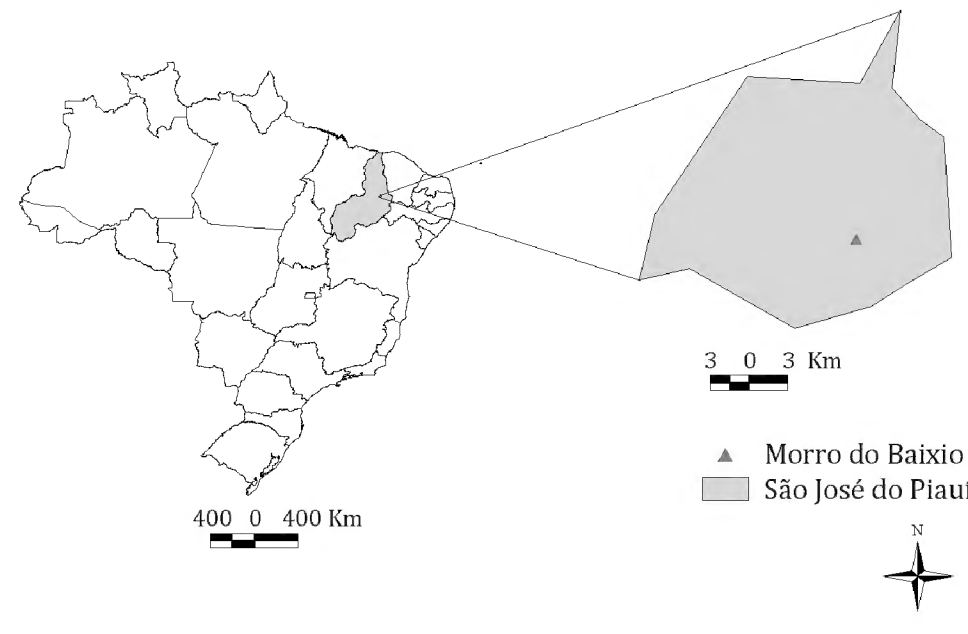

FIGURE 1. Location of the property Morro do Baixio in São José do Piauí, state of Piauí, Brazil.

subsequently incorporated into the TEPB Herbarium collection. Data was organized listing the species and their families, according Cronquist (1988) for convenience of comparison to some floristic lists of Caatinga (Rodal *et al.* 2008; Araújo *et al.* 1995; Ferraz *et al.* 1998; Rodal *et al.* 1999; Figueirêdo *et al.* 2000; Alcoforado-Filho *et al.* 2003; Lemos 2004; Araújo *et al.* 2005; Rodal *et al.* 2005; Costa *et al.* 2007), carrasco (Araújo *et al.* 1998; Araújo and Martins 1999), Caatinga-Carrasco transition (Oliveira *et al.* 1997), evergreen shrub vegetation (Rodal *et al.* 1998), transition from Campo Maior Complex (Farias and Castro 2004) and Cerrado (Castro *et al.* 1998; Ribeiro and Tabarelli 2002).

Species were classified as phanerophytes, camaephytes, hemicryptophytes, geophytes, therophytes, lianas, epiphytes and parasites, according Raunkiaer (1934), adaptated by Mueller-Dombois and Ellenberg (1974), to compare the Caatinga life-form spectrum with Raunkiaer's normal spectrum. This classification is based on the meristematic tissue, which remains inactive to growth during unfavorable season (as dry summer or winter), and therefore the location of this tissue is an essential feature of plant's adaptation to climate (Whittaker 1975). To verify if the life-form spectrum shows significant differences to Raunkiaer's normal spectrum, we used a χ^2 test (Zar 1999). For this comparison, lianas were included like phanerophytes, and epiphytes and woody parasites excluded from the statistical analysis.

Results and Discussion

We recorded 136 species distributed among 104 genera and 47 families (Table 1), including one new species of *Bauhinia*. The families with the greatest number of species were Caesalpiniaceae (15), Fabaceae (11), Bignoniaceae and Mimosaceae (9), Cactaceae and Malpighiaceae (6), and Euphorbiaceae (5), represented by 44.85 %. Twenty one families (44.68 %) were represented by only a single species. In terms of genera, Fabaceae (11), Caesalpiniaceae (7), Bignoniaceae (6), Euphorbiaceae, Malpighiaceae and Mimosaceae (5) were the most representative, being *Bauhinia* (6), *Aspidosperma*, *Eugenia* and *Senna* (3) with the largest number of species.

A comparison of the flora encountered in the presented study with reports from the literature for crystalline and sedimentary formations revealed 33 species (27.96 %) occurring only in the study area, while 85 species (72.03 %) were cited in at least one of the earlier reports. Generally, the more frequent families encountered in this study were representative of the crystalline and sedimentary formations in the semi-arid domain, except for Malpighiaceae. Euphorbiaceae, Mimosaceae, Caesalpinaceae and Cactaceae could be found in crystalline areas (Rodal *et al.* 2008; Araújo *et al.* 1995; Ferraz *et al.* 1998; Alcoforado-Filho *et al.* 2003). In addition to these species, Bignoniaceae, Fabaceae and Myrtaceae could be found in the sedimentary areas, but not Cactaceae (Araújo *et al.* 1998; Araújo and Martins 1999; Lemos 2004).

Rodal *et al.* (2008) reported that Euphorbiaceae, Cactaceae and Caesalpiniaceae were the families with the largest number of species in Caatinga. Lemos and Rodal (2002), studying a deciduous thorny vegetation in the state of Piauí, found that, except for Bignoniaceae and Myrtaceae, there was no distinction between families with the largest number of species in crystalline and sedimentary formations. However, analyzing the species distribution of these families, we found that there were differences among crystalline and sedimentary formations. The higher proportion of species in common (32.2 % with 38 species) occurred in Caatinga sedimentary formations (Rodal *et al.* 2008; Rodal *et al.* 1999; Figueiredo *et al.* 2000; Lemos 2004), followed by Carrasco (31.35 % with 37 species) (Araújo *et al.* 1998; Araújo and Martins 1999), and crystalline formations (29.81 % with 34 species) (Rodal et al 2008; Araújo *et al.* 1995; Ferraz *et al.* 1998; Alcoforado-Filho *et al.* 2003; Lemos 2004, Araújo *et al.* 2005; Rodal *et al.* 2005; Costa *et al.* 2007).

Spondias tuberosa Arruda (Anacardiaceae), *Cuspidaria argentea* (Wawra) Sandw., *Mansoa hirsuta* DC. (Bignoniaceae), *Tournefortia rubicunda* Salzm. ex DC. (Boraginaceae), *Pilosocereus piauhyensis* (Werdm.) Byles & Rowley (Cactaceae), *Chamaecrista eitenorum* (Irwin & Barneby) Irwin & Barneby, *Poeppigia procera* Presl. (Caesalpiniaceae), *Crotalaria holossericea* Nees & Mart. (Fabaceae), *Anadenanthera colubrina* var. *cebil* (Griseb.) Altschul (Mimosaceae), *Ximenia americana* L. (Olacaceae) and *Cardiospermum corindum* L. (Sapindaceae) occurred both in cristalline and sedimentary areas. *Spondias tuberosa* and *Pilososcereus piauhyensis* were the only endemic species (Giulietti *et al.* 2002). The geographical distribution of *Poeppigia procera* needs further investigation and *Crotalaria holossericea* is typical of degraded areas of Caatinga (Queiroz 2002).

We found 24 species (20.34 %) with lists for Cerrado from the state of Piauí (Castro *et al.* 1998; Ribeiro and Tabarelli 2002) and 22 species (18.64 %) with transition from Campo Maior Complex (Farias and Castro 2004). The most common species in 17 flora lists, including this study, were *Cereus jamacaru* DC. (12 lists), *Rollinia leptopetala* (R.E.Fries) Safford (9), *Commiphora leptophloeos* (Mart.) Gillet, *Bauhinia cheilantha* (Bong.) Steud. (8) and *Aspidosperma pyrifolium* Mart. (8). These, except *Bauhinia cheilantha*, were cited by Giulietti *et al.* (2002) as endemic of Caatinga. However, Taylor and Zappi (2002) affirm that these species, despite being predominant, also occur in other vegetation types. *Aspidosperma pyrifolium* also occurred in Cerrado and *Commiphora leptophloeos* in Carrasco and Cerrado. *Bauhinia cheilantha* is cited by many authors (Ferraz *et al.* 1998; Lemos and Rodal 2002) as occurring in crystalline and sedimentary formations.

The flora life-form spectrum in this study showed a high proportion of phanerophytes (64.70 %) followed by lianas (12.50 %), hemicryptophytes (8.09 %), camephytes (5.88 %), geophytes (3.68 %), therophytes (2.94 %), epiphytes (1.47 %) and parasites (0.73 %). Excluding the epiphytes and the parasites, and including the lianas as phanerophytes in the statistical analysis, the life-form spectrum increases the proportion of the phanerophytes (78.95 %), the same dominant pattern observed for Raunkiaer's normal spectrum (Table 2). The χ^2 test demonstrated significant differences between the study area flora and Raunkiaer's normal spectrum ($\chi^2 = 45.20$, $p < 0{,}001$). Phanerophytes had the highest individual value obtained from χ^2 test (52.21 %).

It is important to note that Raunkiaer's normal spectrum was created for world flora and take into account

homogeneous climatic conditions (Cain 1950). The χ^2 test showed significant differences of São José flora from the normal spectrum. Phanerophytes and hemicryptophytes were already cited as the main life-forms of Cerrado (Batalha and Martins 2004).

Studies in semi-arid regions of northeastern Brazil are scarce except for recent studies carried out in Ceará and Pernambuco states (Araújo *et al.* 2005; Rodal *et al.* 2005; Costa *et al.* 2007). Therophytes are expected to register higher proportions in high temperature and low precipitation areas, characterizing the life-form spectrum of arid and semi-arid regions (Raunkiaer 1934; Araújo *et al.* 2005). However, our results show phanerophytes to be dominat, similar to the pattern were found in dry forests and Carrasco areas of the state of Ceará (Araújo *et al.* 2005). This probably must be associated with the precipitation and altitudinal conditions of the study area, as well as the smaller number of species in the herbaceous/sub shrub layer when compared to shrub/woodland layer (99 species, including the woody lianas), a common pattern of sedimentary formations (Rodal *et al.* 1999; Figueiredo *et al.* 2000; Araújo *et al.* 2005).

The flora of Morro do Baixio was composed by a high frequency of typical species of sedimentary Caatinga. However, the geoenvironment of the São José municipality within the "cuesta" of Serra Grande (Rivas 1996) is characterized as a region of Cerrado/Caatinga/Carrasco transition, determining the appearance of species that occur in these formations.

Table 1. List of species, common names, families, and their life-forms in Morro do Baixio, municipality of São José do Piauí, state of Piauí, Brazil.

Family/Species	Common Name	Life-form
Acanthaceae		
Ruellia sp.	_	Hemycryptophyte
Amaranthaceae		
Gomphrena aff. *leucocarpa* Mart.	_	Hemycryptophyte
Pfaffia sp.	_	Hemycryptophyte
Anacardiaceae		
Apterokarpus gardneri (Engler) Rizzini	aroeira-brava	Phanerophyte
Myracrodruon urundeuva Allemão	aroeira	Phanerophyte
Spondias tuberosa Arruda	umbu	Phanerophyte
Annonnaceae		
Rollinia leptopetala (R.E.Fries) Safford	bananinha/açoita	Phanerophyte
Apoynaceae		
Aspidosperma sp.	pequiá	Phanerophyte
Aspidosperma multiflorum A.DC.	pereiro-branco	Phanerophyte
Aspidosperma pyrifolium Mart.	pereiro-preto	Phanerophyte
Araceae		
Tacarum peregrinum L.	milho-de-cobra	Geophyte
Aristolochiaceae		
Aristolochia sp.	_	Geophyte
Asclepiadaceae		
Schubertia cf. *multiflora* Mart.	flor-de-cera	Liana
Petalostelma sp.	cipó-de-tamanduá	Liana
Asteraceae		
Pithecoseris pacourinoides Mart.	_	Hemycryptophyte
Bignoniaceae		
Bignonia sp.	cipó-de-arco	Liana
Cuspidaria argentea (Wawra) Sandw.	_	Phanerophyte
Godmania dardanoi (J.C.Gomes) A.H.Gentry	chifre-de-carneiro	Phanerophyte
Jacaranda jasminoides (Thunb.) Sandw.	jacaranda/carobinha	Phanerophyte
Jacaranda praetermissa Sandw.*	caroba	Phanerophyte
Mansoa hirsuta DC.	cipó-de-alho	Liana
Mansoa difficilis (Cham.) Bur. and K.Schum.	cipó-de-tamanduá	Liana
Tabebuia impetiginosa (Mart. *ex* DC.) Standl.	pau-d'árco-roxo	Phanerophyte
Tabebuia serratifolia (Vahl.) Nich.	pau-d'árco-amarelo	Phanerophyte
Bixaceae		
Cochlospermum vitifolium (Willd.) Spreng.	algodão-bravo	Phanerophyte
Bombaceae		
Eriotheca sp.	barriguda	Phanerophyte
Pseudobombax marginatum (A.St.-Hil.) A.Robyns	imbiratanha	Phanerophyte
Boraginaceae		
Cordia rufescens A.DC.	grão-de-galo	Phanerophyte
Cordia trichotoma Vell.	frei-jorge/freijó	Phanerophyte
Tournefortia rubicunda Salzm. *ex* DC.	cipó-de-anjo	Liana
Bromeliaceae		
Bromelia plumieri (E.Morren) L.B.Sm.	macambira	Hemycryptophyte
Tillandsia loliacea Mart. *ex* Schult.F.	_	Epiphyte
Tillandsia streptocarpa Baker	_	Epiphyte
Bursceraceae		
Commiphora leptophloeos (Mart.) Gillet	imburana-de-cambão	Phanerophyte

Table 1. List of species, common names, families, and their life-forms in Morro do Baixio, municipality of São José do Piauí, state of Piauí, Brazil. (Continued)

Family/Species	Common Name	Life-form
Cactaceae		
Cereus albicaulis (Britton & Rose) Luetzelb.	rabo-de-raposa	Phanerophyte
Cereus jamacaru DC.	mandacaru	Phanerophyte
Melocactus zehntneri (Britton and Rose) Luetzelb	croa-de-frade	Camephyte
Pilosocereus gounellei (F.A.C. Weber) Byles and Rowley	xique-xique	Phanerophyte
Pilosocereus piauhyensis (Werdm.) Byles and Rowley	facheiro	Phanerophyte
Tacinga inamoena (K.Schum) N.P.Taylor and Stuppy	palmatória	Camephyte
Caesalpiniaceae		
Bauhinia cheilantha (Bong.) Steud.	mororó	Phanerophyte
Bauhinia pentandra (Bong.) Steud.	mororó	Phanerophyte
Bauhinia pulchella Benth.	mororó	Phanerophyte
Bauhinia subclava Benth.	mororó	Phanerophyte
Bauhinia sp. nov.	mororó	Phanerophyte
Bauhinia ungulata L.	mororó	Phanerophyte
Caesalpinia bracteosa Tul.	catinga-de-porco	Phanerophyte
Caesalpinia ferrea Mart. *ex* Tul.	jucá/pau-ferro	Phanerophyte
Chamaecrista eitenorum (Irwin & Barneby) Irwin & Barneby	birro-preto	Phanerophyte
Hymenaea stigonocarpa Mart. *ex* Hayne	jatobá-de-vaqueiro	Phanerophyte
Peltogyne confertiflora (Hayne) Benth.	jatobazinho	Phanerophyte
Poeppigia procera Presl.	_	Phanerophyte
Senna acuruensis (Benth.) Irwin & Barneby	canafistinha	Phanerophyte
Senna cearensis A.Fern.	oca	Phanerophyte
Senna spectabilis var. *excelsa* (Schrad) Irwin & Barneby	_	Phanerophyte
Capparaceae		
Capparis hastata L.	feijão-bravo	Phanerophyte
Cleome guianensis Aublet	_	Therophyte
Crateva tapia L.	trapiá	Phanerophyte
Combretaceae		
Combretum leprosum Mart.	mofumbo	Phanerophyte
Combretum mellifluum Eichler	sipaubinha	Phanerophyte
Terminalia actinophylla Mart.	chapada	Phanerophyte
Thiloa glaucocarpa (Mart.) Eichler	sipaúba-branca	Phanerophyte
Convolvulaceae		
Ipomoea brasiliana (Choisy) Meisn	cabacinha-braba	Liana
Evolvulus sp.	_	Hemicriptófito
Dioscoriaceae		
Dioscorea glandulosa Klotzsch ex Knuth	_	Camephyte
Erythroxylaceae		
Erythroxylum laetevirens O.E.Schulz	carocinho	Phanerophyte
Erythroxylum subracemum Turcz	carocinho	Phanerophyte
Euphorbiaceae		
Croton celtifolius Baill.	marmeleiro-preto	Phanerophyte
Dalechampia affinis Mül.Arg.	_	Liana
Euphorbia comosa Vell.	_	Camephyte
Manihot anomala Pohl	maniçoba-braba	Phanerophyte
Sapium cf. *obovatus* Kl.	mangaba	Phanerophyte
Fabaceae		
Amburana cearensis (Allemão) A.C.Sm.	imburana-de-cheiro	Phanerophyte
Crotalaria holossericea Nees & Mart.	modubim-brabo	Camephyte
Dioclea grandiflora Mart. *ex* Benth.	mucunã	Liana
Galactia texana A.Gray	_	Hemicriptófito
Lonchocarpus araripensis Benth.	amargoso	Phanerophyte
Luetzelburgia auriculata Ducke	pau-mocó	Phanerophyte
Machaerium acutifolium Vogel	coração-de-negro	Phanerophyte
Macroptilium martii (Benth.) Maréchal & Baudet	_	Liana
Pterocarpus villosus Mart. *ex* Benth.	_	Phanerophyte
Swartzia fleemmingii Raddi	jacarandá	Phanerophyte
Vigna cf. *penduncularis* Fawc. & Rendle	feijão-bravo	Liana
Lamiaceae		
Indetermined	_	Therophyte
Liliaceae		
Alstroemeria piauhyensis Gardner *ex* Baker	senhora-me-deixe	Geophyte
Hippeastrum aff. *solandriflorum* Herb.	_	Geophyte
Zephyranthes sylvatica Baker	cebolinha	Geophyte
Loranthaceae		
Strutantus sp.	erva-de-passarinho	Parasite
Lythraceae		

Table 1. List of species, common names, families, and their life-forms in Morro do Baixio, municipality of São José do Piauí, state of Piauí, Brazil. (Continued)

Family/Species	Common Name	Life-form
Cuphea ericoides Cham. & Schlech.	_	Therophyte
Malpighiaceae		
Byrsonima correifolia A.Juss.	murici	Phanerophyte
Byrsonima lutea (Griseb.) Cuatrec.	_	Liana
Banisteriopsis stellaris (Griseb.) B.Gates	enfeito-de-grinalda	Liana
Barnebya harleyi W.R.Anderson & B.Gates	murici-do-agreste	Phanerophyte
Peixotoa jussieuana A.Juss	flor-de-anjo	Phanerophyte
Stigmatophyllon paralias A.Juss.	_	Hemycryptophyte
Malvaceae		
Sida ulei Ulbr.	malva-branca	Camephyte
Mimosaceae		
Acacia piauiensis Benth.	jurema	Phanerophyte
Acacia sp.	_	Phanerophyte
Albizia polycephala (Benth.) Killip	_	Phanerophyte
Anadenanthera colubrina var. *cebil* (Griseb.) Altschul	angico-preto	Phanerophyte
Indetermined	maracaipe	Phanerophyte
Mimosa sensitiva L.	_	Hemicriptófito
Mimosa tenuiflora (Willd.) Poir.	jurema-preta	Phanerophyte
Piptadenia moniliformis Benth.	mama-de-bezerra	Phanerophyte
Piptadenia stipulaceae (Benth.) Ducke	jurema-branca	Phanerophyte
Myrtaceae		
Eugenia cf. *azuruensis* O.Berg.	goiaba-braba	Phanerophyte
Eugenia flavescens DC.	araçá-brabo	Phanerophyte
Eugenia piauhiensis Berg.	araçá-de-pombo	Phanerophyte
Nyctaginaceae		
Guapira sp.	farinha-velha	Phanerophyte
Olacaceae		
Ximenia americana L.	ameixa	Phanerophyte
Opiliaceae		
Agonandra brasiliensis Miers	marfim	Phanerophyte
Passifloraceae		
Passiflora cincinnata Mast.	maracujá-do-mato	Liana
Passiflora edmundoi Sacco	_	Liana
Rhamnaceae		
Ziziphus cotinifolia Reissek	juazeiro	Phanerophyte
Rubiaceae		
Alibertia edulis (L.C.Rich.) A.Rich. *ex* DC.	marmelada	Phanerophyte
Coutarea hexandra (Jacq.) K.Schum.	quina-quina	Phanerophyte
Richardia scabra L.	ervancinha	Hemycryptophyte
Rutaceae		
Zanthoxylum rhoifolium Lam.	laranjinha	Phanerophyte
Zanthoxylum stelligerum Turcz.	laranjinha	Phanerophyte
Sapindaceae		
Cardiospermum corindum L.	pustemeira	Liana
Magonia pubescens A.St.-Hil.	tingui	Phanerophyte
Serjania caracasana (Jacq.) Willd.	moita-de-cururu	Liana
Scrophulariaceae		
Angelonia sp.	mãe-maria	Therophyte
Solanaceae		
Capsicum parvifolium Seudtn	alecrim-quebrabo	Phanerophyte
Solanum crinitum Lam.	jurubeba	Phanerophyte
Solanum cf. *chytidoaudrum* Lam.	jurubeba-braba	Phanerophyte
Sterculiaceae		
Helicteres baruensis Jacq.	guaxum	Phanerophyte
Helicteres muscosa Mart.	pimenta-de-mocó	Phanerophyte
Waltheria sp.	malva	Hemycryptophyte
Turneraceae		
Turnera blanchetiana Urb.	_	Phanerophyte
Verbenaceae		
Amasonia campestris L.	flor-de-alma	Camephyte
Lantana canescens Kunth	alecrim-quebrado	Phanerophyte
Vitex sp.	pinho-brabo	Phanerophyte
Indetermined	_	Phanerophyte
Vitaceae		
Cissus sp.	_	Camephyte
Vochysiaceae		
Callisthene microphyla Warm.	carocinho	Phanerophyte

Table 2. Results of χ^2 tests of Morro do Baixio, municipality of São José, and Raunkiaer's normal spectrum.

Life-form class	% expected	% observed	χ^2
Phanerophytes	46.00	78.95	23.60
Camephytes	9.00	6.01	0.99
Hemicryptophytes	26.00	8.27	12.09
Geophytes	6.00	3.76	0.84
Therophytes	13.00	3.01	7.68
Total	**100.00**	**100.00**	**45.20**

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